The present invention discloses a robot joint control apparatus, which controls the movement of a robot joint using an actuator. The actuator or motor (i.e. M-1 through M-14) includes electric current detection means, torque detection means and control means. *See* the specification on page 18, lines 9-18, and Figs. 9 and 19. The advantage of including the control means inside the actuator itself is that the robot becomes more compact because less external control components are required to operate the joints of the robot. The more compact the robot is, the more maneuverable the robot becomes in operation.

The present invention also reduces the amount of wires that are typically installed in such an apparatus. The wires connect the various joint motors to each other and to a main control panel. Known joint control apparatus, such as the control disclosed in *Onaga et al.*, include complex wiring schemes, which require a large number of wires to control the joints. More wires at or near the moving joints of the robot increases the likelihood that one or more of the wires will tear or break during movement of the joints. In particular, the wires in the arms of a robot are subject to greater stresses than other parts of the robot because the arms rotate in several directions and move more frequently than the other parts. The claimed invention reduces the likelihood of a wire tearing or breaking in a joint because the electric current detection means, torque detection means and the control means are located inside each motor. Therefore, less wires are needed to connect the various components of the robot.

On the contrary, *Onaga et al.* does not disclose electric current detection means, torque detection means, and control means in the actuator itself. Instead, *Onaga et al.* discloses a multi-axis digital robot control which utilizes a torque processor board 600, a servo control board 400 and an AIF board 800 to completely provide six access control for a robot arm. These boards thereby control all of the movements of the joints in the robot arm. As shown in Fig. 4 of *Onaga*

et al., the boards 400, 600, and 800 are all external to the robot 20. Therefore the control boards are not located within the motors inside the joints of the robot and substantial wiring is required to connect the boards to the joints of the robot. The control method used in *Onaga et al.*, as a result, provides a complex control system which involves complex wiring and circuits from the boards 400, 600 and 800 to the joints. This increases the likelihood that the wiring will tear or break during rotation of the joints and also makes the robot unit itself much heavier, less mobile and cumbersome.

The Patent Office acknowledges that the *Onaga et al.* reference does not disclose an "actuator including a current detector, a torque detector, and control means" as in the claimed invention. See page 4 of the Final Office Action. The Patent Office therefore relies on *Tsai et al.* to remedy this deficiency. The Patent Office alleges that *Tsai et al.* discloses an actuator including control means and torque detectors as in the claimed invention. Specifically, the Patent Office refers to column 9, lines 3-19 of *Tsai et al.* as disclosing the claimed subject matter.

The Tsai et al. reference discloses actuators 2 and 3 which drive the joints respectively. The actuators are motors "whose torque is controlled by either a computer, a PD controller or a PID controller." See Col. 9, lines 5-11. In particular, the controllers, or computer, use sensors to detect the position and velocity of the joints and then process control signals that are sent to the actuators. Therefore, the control devices in *Tsai et al.* are not located in the actuators themselves, but are separate units located at some other portion of the robot arm or unit. Thus, *Onaga et al.* in view of *Tsai et al.*, when viewed as a whole, does not teach or suggest providing an electric current detector, an external force torque detector and control means in the actuator or motor case to control the movement of the robotic joints.

Therefore, the combination of *Onaga et al.* and *Tsai et al.* does not disclose an actuator or motor that includes control means such as the electric current detection means and external force torque detection means as in the claimed invention. Instead, the cited references use control boards or controllers that are external from the joint motors to detect the electric current and to control the torque in the motors.

In light of the above, Applicants respectfully submit that Claims 1, 3, 4, 6, 8, 9, and 11-22 are both novel and non-obvious over the art of record because the combination of *Onaga et al.* and *Tsai et al.* does not teach or suggest all of the limitations of the claimed invention. Accordingly, Applicants respectfully request that Claims 1, 3, 4, 6, 8, 9, and 11-22, be deemed allowable at this time and that a timely Notice of Allowance be issued in this case.

Respectfully submitted,

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